Health Preservation Over Food Preservation

Introduction

The food industry has grown tremendously over the last century. The small family farms that had previously dominated the countryside have been displaced by large corporations. To keep up with their competitors, these corporations are incessantly looking for ways to increase the transportability, shelf-life, and customer appeal of their products, while simultaneously reducing production costs. The advances in food production technology during this same time period has enabled firms to achieve these goals through the manufacturing of synthetic preservatives and additives. These artificial substances are inexpensive to produce, able to extend shelf-life almost indefinitely, and able to alter the appearance and taste of food to make it more appetizing to consumers. With the increasing rate of globalization over the past couple decades and the rapid pace of Western lifestyle, more corporations have turned to these synthetic substances to gain a competitive edge in the global market and provide consumers with more convenient food options (Carocho, Morales, and Ferreira 2015). However, inexpensive and convenient food is not equivalent to safe food. Widespread use of synthetic preservatives and additives has negatively impacted human health, consequently stimulating the search for natural alternatives.

Synthetic Preservatives: Categorization

Preservation in itself is not a new concept, as salt has been used for millennia to preserve meats and cheeses. It is simply the method and scale of preservation that has changed. Like their
natural predecessors, synthetic preservatives are used in food to prevent spoilage (Martínez-Gracia et al. 2015). These artificial preservatives are categorized into antimicrobial agents, antioxidants, and anti-browning agents, depending on their mode of preservation (Carocho, Morales, and Ferreira 2015). Antimicrobials are substances that are toxic to bacteria, yeast, fungi and other microorganisms. When added to food, these chemicals delay the onset of microorganism growth, enabling the food to be stored for a greater period of time. Antioxidants, as their name implies, prevent the oxidation of fats (Carocho, Morales, and Ferreira 2015). When fats are oxidized, they destabilize the structure and degrade the flavor of food (Carocho, Morales, and Ferreira 2015). By preventing this process, antioxidants contribute to longer-lasting food as well. Finally, anti-browning agents are used to preserve the color of the food by reducing polyphenol oxidase activity (Carocho, Morales, and Ferreira 2015). Polyphenol oxidases are enzymes that, when exposed to oxygen during food processing, destroy phenolic compounds, resulting in food discoloration (Carocho, Morales, and Ferreira 2015). It is important to note that this categorization is not all-inclusive, as many synthetic preservatives are able to use more than one of the above mechanisms to extend the shelf-life of food. Regularly consumed artificial preservatives that perform these functions include sodium nitrate, sodium sulfate, potassium nitrate, potassium sulfate, sodium benzoate, citric acid, butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA), and disodium ethylenediaminetetraacetic acid (EDTA).

*Synthetic Preservatives: Health Impacts*

These man-made preservatives are tested by the FDA to ensure that they are “safe.” This is not referring to the toxicity of the substance itself, but to the greatest dose that can be consumed without experiencing adverse health effects. The maximum dose is then divided by 100 (or 1000 in the case of extremely toxic preservatives) to guarantee that the amount used in food does not exceed this value (Amchova, Kotolova, and Ruda-Kucerova 2015). However,
these tests only examine each substance individually. This is in contrast to the use of preservatives in food, where it is not uncommon for several to be used at once. Sarıkaya and Çakır noticed this asymmetry between lab and life situations and conducted a study on the effects of four common preservatives—sodium nitrate, sodium sulfate, potassium nitrate, and potassium sulfate—on wing mutations in fruit flies (2005). In the first stage of this study, fruit flies were fed a single preservative at varying concentrations. For each concentration, the number of spots on the fruit flies’ wings were counted; these spots represented mutation in the wing cells’ DNA. The data revealed that the number of wing spots was directly proportional to the concentration of preservatives in the food medium. For the second stage of the study, all four preservatives were fed to the fruit flies, each at a low concentration. In this case, the presence of mutation was significantly higher than when they were fed only one preservative. This demonstrates the synergistic effect of using multiple preservatives, even in small amounts, and the consequent danger it poses to human health (Sarıkaya and Çakır 2005).

Türkoğlu performed a similar study testing the effect of five food preservatives—sodium benzoate, boric acid, citric acid, potassium citrate, and sodium citrate—on the root tips of onions (2007). Because root tips contain the rapidly dividing cells of the meristematic region, it would be the ideal place to observe possible mutations induced by the artificial preservatives. The experimental setup consisted of five jars of water, each containing one of the preservatives, and a sixth jar containing only water, acting as the negative control. The onion roots were placed into the water and examined at 5, 10, and 20 hours. This process was repeated for various preservative concentrations—20, 40, 60, 80, and 100ppm (Türkoğlu 2007). Like Sarıkaya and Çakır, Türkoğlu observed a significant increase in the number of mutations as the preservative concentration increased (2005; 2007). Though, Türkoğlu also noticed that mitotic activity of the cells declined as the length of time they were exposed to these preservatives increased (2007).
Notably, cell division ceased entirely after 20 hours of exposure to the 100ppm citric acid (Türkoğlu 2007). This indicates that long-term consumption of preservatives may impair the body’s ability to replace worn out cells, resulting in premature aging and other diseases.

In the aforementioned studies, synthetic preservatives interfered with the body’s repair mechanisms by interrupting cell division processes, but this is not always the case. For instance, Maier et al. conducted a study illustrating that preservatives can also interrupt repair mechanisms by altering the body’s immune response (2010). In this study, sodium benzoate had changed neopterin, tryptophan, and cytokine levels, shifting the immune response from a Th-1 to a Th-2 response. The Th-1 response is responsible for the inflammation needed to fight bacterial and parasitic infections, so shifting from a Th-1 to Th-2 response could hinder the immune system’s ability to destroy foreign invaders. However, curcumin, a natural food colorant in the study, had a similar effect, enabling it to combat the inflammation of autoimmune diseases. Based on this analysis, it is not certain whether the effect of synthetic preservatives on immune response is entirely negative; yet, it is important to note that they do alter the body’s immune response (Maier et al. 2010).

*Synthetic Additives: Categorization*

Though synthetic preservatives typically have a functional purpose, the same is not true of synthetic additives. Corporations integrate additives into their food solely with the purpose of making food more attractive and desirable to consumers. This then increases the marketability of their products. Artificial additives can be categorized into coloring agents, flavoring agents, and texturizing agents (Carocho, Morales, and Ferreira 2015). Coloring agents (colorants) are used to enhance color that has been lost during food processing or to add color that was never present initially. These substances are further sub-divided based on the compounds they are derived from, which include the azo compounds, chinophthalon derivatives, triaryl methane compounds,
xanthenes, and indigos (Carocho, Morales, and Ferreira 2015). Flavoring agents are used to add certain flavors to processed foods that were not originally present. This is often through the addition of artificial sweeteners like high fructose corn syrup. Although acids may also be added to impart a sour taste. This is true of the citric acid present in many sodas. Finally, texturizing agents are used to retain the consistency of the food. There are two types of texturizing agents—emulsifiers and stabilizers (Carocho, Morales, and Ferreira 2015). Emulsifiers keep the components of a mixture evenly distributed. For example, carrageenan is used in chocolate milk to keep the chocolate from settling out. On the other hand, stabilizers are used to maintain the existing texture of food. The FDA recognizes high fructose corn syrup, soy lethicin, olestra, xanthan gum, monosodium glutamate (MSG), carrageenan, guar gum, glycerin, sorbitol, aspartame, Yellow 5 (tartrazine), Blue 1 (brilliant blue), Red 3 (erythrosine), and caramel color as some examples of common synthetic additives (IFIC and FDA 2004; Amchova, Kotolova, and Ruda-Kucerova 2015).

**Synthetic Additives: Health Impacts**

Like artificial preservatives, artificial additives have many adverse effects on human health. Amchova, Kotolova, and Ruda-Kucerova note that asthma and allergies have become more prevalent in recent years (2015). Though this may be due to a variety of factors, the increased use of food additives is likely one reason for the epidemic. Food colorants in particular seem to incite allergic reactions. Amchova, Kotolova, and Ruda-Kucerova reference several studies in which Patent Blue caused severe allergic reactions when injected directly into the bloodstream (2015). Though this does not occur during digestion, it is possible for the colorant to be absorbed directly into the bloodstream by the oral mucosa (Amchova, Kotolova, and Ruda-Kucerova 2015). Additional research regarding this situation may deem this colorant unsafe. Similarly, Green S and Brown HT are able to cause allergic reactions in hypersensitive people,
though not as severely as Patent Blue (Amchova, Kotolova, and Ruda-Kucerova 2015). Further complicating matters, food colorants that the FDA does not require to be included on nutrition labels are all lumped under “artificial colors” (IFIC and FDA 2004). This makes it extremely difficult for people to identify and avoid the colorants that they are allergic to.

Artificial additives can also cause irritability and hyperactivity in children. According to Amchova, Kotolova, and Ruda-Kucerova, food colorants are believed to be a causative agent of ADD and ADHD (2015). Amchova, Kotolova, and Ruda-Kucerova reference a 2007 study in which children were offered drinks containing a mixture of colorants, including Sunset Yellow, Azorubine, Quinoline Yellow, Tartrazine, Allura Red, and Ponceau 4R (2015). The study revealed a significant correlation between ingestion of food colorants and development of ADHD. Amchova, Kotolova, and Ruda-Kucerova also reference another study testing the relationship between food colorants and ADHD (2015). In this study, intake of food colorants was reduced for children with ADHD. Eight percent of these children simultaneously experienced a reduction of ADHD symptoms. Stevens et al. mentions this study as well, noting that 33% of children with ADHD could benefit by eliminating foods with high colorant content from their diets (2013). According to Stevens et al., the number of artificial food colorants certified by the FDA was five times greater in 2010 than it was in 1955 (2013). It is no surprise then that ADD and ADHD have become more frequent.

Furthermore, artificial additives may also cause degradation or mutation of DNA, which would consequently increase the risk of cancer. Amchova, Kotolova, and Ruda-Kucerova reference multiple studies in which food colorants Quinoline Yellow, Sunset Yellow, and Brilliant Black damaged the DNA of human blood lymphocytes (2015). Brilliant Black and Sunset yellow have also been found to impair DNA in fava beans and field mustard, respectively (Amchova, Kotolova, and Ruda-Kucerova 2015). Additional studies have illustrated that
Brilliant Blue interferes with cell division and Azorubin alters the physical appearance of chromosomes (Amchova, Kotolova, and Ruda-Kucerova 2015). Tartrazine can even bind to DNA directly, making it a likely carcinogen at high doses (Amchova, Kotolova, and Ruda-Kucerova 2015). Similarly, in a 1990 study, Erythrosine, a red xanthen dye, induced thyroid tumors in rodents when it was consumed (Amchova, Kotolova, and Ruda-Kucerova 2015). However, this was not due to DNA damage. This occurred because Erythrosine contains iodine ions that interfere with normal thyroid function, resulting in an overproduction of hormones and consequent tumor development (Amchova, Kotolova, and Ruda-Kucerova 2015). These studies indicate that synthetic additives can cause cancer directly through genotoxic mechanisms or indirectly by interrupting the body’s natural processes.

Natural Alternatives: Categorization

As studies continue to confirm the negative impacts of synthetic preservatives and additives, the public is becoming increasingly concerned. This has prompted a search for natural alternatives. According to Carocho, Morales, and Ferreira, there is no true legal definition for natural preservatives and additives (2015). Though Martínez-Gracia et al. recognize that “natural” implies the substance is harvested from plants, animals, or microorganisms, rather than produced or modified in a lab setting (2015). Similar to their artificial counterparts, natural preservatives and additives can be categorized into antimicrobials, antioxidants, colorants, and sweeteners (Carocho, Morales, and Ferreira 2015).

Many natural antimicrobials are gathered from microorganisms themselves. These substances include natamycin, reuterin, and over 300 bacteriocins used in the coatings of meats, dairy products, eggs, and various other foods (Carocho, Morales, and Ferreira 2015). Animal-derived antimicrobials include Poly-L-Lysine, lysozyme, lactoperoxidase, and lactoferrin (Carocho, Morales, and Ferreira 2015). Their primary use is in the dairy industry as well, though
they are used occasionally in beef and food coatings (Carocho, Morales, and Ferreira 2015). Essential plant oils such as oregano oil, thymol, carvacrol, clove oil, and cinnamon oil are also utilized in meat, fish, dairy products, vegetables, rice, and fruit as antimicrobial agents (Carocho, Morales, and Ferreira 2015).

Natural antioxidants, colorants, and sweeteners are primarily derived from plants. Natural antioxidants include ascorbic acid, polyphenols, carotenoids, and tocopherols; these extracts are primarily used in meats, oils, fried foods, dressings, dairy products, and baked goods (Carocho, Morales, and Ferreira 2015). Natural colorants comprise carotenoids, anthocyanins, betalains, chlorophylls, curcumin, annatto, paprika, caminic acid, and lutein (Carocho, Morales, and Ferreira 2015; Rodriguez-Amaya 2016). Finally, natural sweeteners include those less sweet than sucrose—erythritol and tagatose—and those sweeter than sucrose—steviol glycosides, glycyrrhizin, and thaumatin (Carocho, Morales, and Ferreira 2015).

Natural Alternatives: Advantages and Disadvantages

The advantages of using natural preservatives and additives are very straightforward. First, in addition to fulfilling their role in food production, they have many added health benefits due to their high nutritional content and other natural properties. For example, the antioxidant activity of polyphenols appears to mitigate cancer, osteoporosis, cataracts, cardiovascular dysfunctions, brain diseases, and immunological diseases (Carocho, Morales, and Ferreira 2015). Secondly, using natural preservatives and additives poses fewer health risks than using artificial ones, as there are no synthetic chemical substances to disrupt normal bodily functions.

In contrast, the disadvantages of natural preservatives and additives are much more complex. One drawback is that they must be harvested from natural sources, which makes them more difficult to obtain and increases production costs. Also, if there are very few sources for a particular substance, overharvesting could be a potential problem (Carocho, Morales, and
Ferreira 2015). Harvesting in different geographic locations and seasons could result in inconsistent concentrations of the preservatives and additives as well (Martínez-Gracía et al. 2015). In another respect, Rodriguez-Amaya notes that natural substances are often less potent, stable, and diverse; this requires using greater amounts, which may create undesirable flavors and increase costs (2016). Though, the use of encapsulation for longer-lasting results and combinations of multiple natural substances for synergistic strength provide promising solutions for the stability and potency issues, respectively (Rodriguez-Amaya 2016). Finally, lack of legislation separating natural and artificial standards could create possible barriers (Carocho, Morales, and Ferreira 2015).

Conclusion

Evidently, synthetic preservatives and additives act as antimicrobials, antioxidants, ant-browning agents, colorants, flavoring agents, and texturizing agents to lower production costs, extend shelf-life, and increase desirability of food. Though useful in food production, these artificial substances adversely affect human health by inducing DNA mutation, interrupting cell division, altering immune response, inciting allergic reactions, influencing children’s behavior, and causing carcinogenic activity. In light of these recent findings, there has been an increased demand for natural preservatives and additives, which lower health risks and provide added health benefits. Unfortunately, their instability, low potency, low diversity, variability from environmental factors, greater cost, difficult acquisition, and absence from legislation make them an inconvenient option at the present time. Though, efforts are being taken to improve their efficiency through encapsulation and combination, and research on the utilization of natural alternatives continues to progress. Certainly, a future shift to natural preservatives and additives is possible. But the real question is whether large corporations will value health preservation over food preservation.


